

Dust Emissions from Cattle Feed Yards

A Source of Antibiotic Resistance?

The practice of using antibiotics in modern cattle-feeding operations has caused concerns about its potential contribution to the spread of antimicrobial resistance.^{1,2,3} In this issue of *EHP*, researchers examine the extent to which five commonly used antibiotics, together with antibiotic-resistance genes and ruminant-associated microbes, disperse from large-scale cattle feed yards via airborne particulate matter (PM).⁴

Antibiotics administered via livestock feed are not fully metabolized, and metabolites and parent compounds are excreted through feces and urine that accumulate on feed yard floors.^{1,5} Subsequent trampling, particularly in dry conditions, contributes to the aerosolization of this material, which can then be transported by air.⁶ This is especially true during the high-wind events that are common to the region where most U.S. beef cattle are raised—the semi-arid Southern High Plains encompassing parts of Texas, Oklahoma, Kansas, Nebraska, and Colorado, including the epicenter of the 1930s Dust Bowl.⁷

“Up to eighty percent of the antibiotics that are consumed by the cattle are not metabolized, so we thought we’d be able to find antibiotics in the particulate matter,” says lead author Andrew McEachran, currently a PhD candidate in environmental toxicology at North Carolina State University. McEachran performed the research at Texas Tech University under faculty adviser and coauthor Philip Smith.

For 2012 the U.S. Food and Drug Administration reported that 19.6 million pounds of antibiotics considered medically important for human health were sold for use in farm animals in the United States,⁸ up from 18.1 million and 18.2 million pounds in 2010 and 2011, respectively.^{9,10} Nearly a third of the antibiotics sold for veterinary use in 2012 were ionophores, a class of drug that is not used in humans.⁸ Antibiotics are used to treat or control potentially fatal ailments in cattle including pneumonia¹¹ and foot rot.¹² The ionophore monensin is used to prevent coccidiosis¹³ as well as to increase weight gain and improve the conversion of food to energy.¹⁴

Excreted antibiotics were already known to enter the environment through feed yard runoff and through the application of manure onto agricultural fields.^{15,16} There is evidence that, once in the environment, antibiotics and antibiotic-resistance genes in bacteria may facilitate new antibiotic resistance or directly transfer genetic resistance to other microbial populations.^{2,3} The goal of this study was to assess whether airborne PM offers another avenue for antibiotics to escape cattle feed yards.

Using portable air samplers, the authors collected PM from positions 20–30 meters up- and downwind of 10 feed yards located within 200 miles of Lubbock, Texas. Each feed yard had the capacity to feed 20,000–50,000 head of cattle. They then used tandem mass spectrometry to identify and quantify five targeted antibiotic compounds: monensin, the macrolide tylosin, and the tetracycline antibiotics tetracycline, chlorotetracycline, and oxytetracycline. They used quantitative polymerase chain reaction (qPCR) to detect nine antibiotic-resistance genes, and amplicon resequencing of 16S rRNA genes to analyze microbial diversity.⁴

Upon tabulating their data, the authors found monensin in 100% of samples up- and downwind of feed yards, with a mean downwind concentration of 1,800 ng/g PM. Tylosin was measured in 80% of samples downwind of feed yards, and the three tetracyclines were present together in 60% of downwind samples, with oxytetracycline detected individually in all downwind samples.⁴

Bacteria common to fecal matter and gut flora, many of them human pathogens, were detected at significantly higher levels in downwind PM samples than in upwind samples. The authors also found levels of six tetracycline-resistance genes to be significantly higher in PM collected downwind of feed yards than upwind, with TetQ and TetW most prevalent across all locations.⁴



Dust is being examined as a possible avenue by which antibiotics escape animal feed yards.

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Samuel Ives, an associate professor at West Texas A&M University and a beef cattle veterinarian, who was not affiliated with the study, points out that bacterial resistance mechanisms to the ionophore class of antibiotic are unique; there is little evidence that resistance to these drugs contributes to resistance against medically important classes of antibiotics.¹⁷

Ives agreed with the authors that these results do not reveal how far the antibiotics and genes travel, or their environmental fate. qPCR techniques only reveal the presence of bacteria, not their viability. “That doesn’t translate to transference to the environment and beyond,” Ives says. “Really what we’re concerned about is, what is the risk of the transmission of these products into the environment relative to human health?”

Smith notes that his team intends to pursue these questions in subsequent research. He says, “We see our role as adding data and information to the discussion on stewardship of antibiotics.”

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REFERENCES

- Shuford JA, Patel R. Antimicrobial growth promoter use in livestock: implications for human health. *Rev Med Microbiol* 16(1):17–24 (2005); doi:10.1097/00013542-200501000-00003.
- Gilchrist MJ, et al. The potential role of concentrated animal feeding operations in infectious disease epidemics and antibiotic resistance. *Environ Health Perspect* 115(2):313–316 (2007); doi:10.1289/ehp.8837.
- Silbergeld EK, et al. Industrial food animal production, antimicrobial resistance, and human health. *Annu Rev Public Health* 29:151–169 (2008); doi:10.1146/annurev.publhealth.29.020907.090904.
- McEachran AD, et al. Antibiotics, bacteria, and antibiotic resistance genes: aerial transport from cattle feed yards via particulate matter. *Environ Health Perspect* 123(4):337–343 (2015); doi:10.1289/ehp.1408555.
- Khan SJ, et al. Chemical contaminants in feedlot wastes: concentrations, effects and attenuation. *Environ Int* 34(6):839–859 (2008); doi:10.1016/j.envint.2007.10.007.
- Von Essen SG, Auvermann BW. Health effects from breathing air near CAFOs for feeder cattle or hogs. *J Agromedicine* 10(4):55–64 (2005); doi:10.1300/J096v10n04_08.
- USDA. Cattle on Feed. Washington, DC:National Agricultural Statistics Service, Agricultural Statistics Board, U.S. Department of Agriculture (March 2014). Available: <http://goo.gl/GbzhLe> [accessed 11 March 2015].
- FDA. 2012 Summary Report on Antimicrobials Sold or Distributed for Use in Food-Producing Animals. Rockville, MD:Center for Veterinary Medicine, U.S. Food and Drug Administration (updated September 2014). Available: <http://goo.gl/eiFFRc> [accessed 11 March 2015].
- FDA. 2011 Summary Report on Antimicrobials Sold or Distributed for Use in Food-Producing Animals. Rockville, MD:Center for Veterinary Medicine, U.S. Food and Drug Administration (updated September 2014). Available: <http://goo.gl/5ngRxU> [accessed 11 March 2015].
- FDA. 2010 Summary Report on Antimicrobials Sold or Distributed for Use in Food-Producing Animals. Rockville, MD:Center for Veterinary Medicine, U.S. Food and Drug Administration (updated September 2014). Available: <http://goo.gl/VRKJX4> [accessed 11 March 2015].
- Merck & Co., Inc. Bacterial pneumonia in cattle. In: *The Merck Veterinary Manual* (Aiello SE, Moses MA, eds.). Whitehouse Station, NJ:Merck & Co., Inc. (updated March 2012). Available: <http://goo.gl/zLdZ3K> [accessed 11 March 2015].
- Virginia Cooperative Extension. Foot Rot in Beef Cattle [website]. Blacksburg, VA:Virginia Polytechnic Institute and State University/Virginia State University (updated 1 May 2009). Available: <https://pubs.ext.vt.edu/400/400-310/400-310.html> [accessed 11 March 2015].
- Merck & Co., Inc. Overview of coccidiosis. In: *The Merck Veterinary Manual* (Aiello SE, Moses MA, eds.). Whitehouse Station, NJ:Merck & Co., Inc. (updated March 2012). Available: <http://goo.gl/zLdZ3K> [accessed 11 March 2015].
- Elanco. Rumensin (monensin) for Pasture Cattle [website]. Greenfield, IN:Elanco Animal Health (2015). Available: <http://www.elanco.us/products-services/beef/rumensin-p.aspx> [accessed 11 March 2015].
- Chee-Sanford JC, et al. Fate and transport of antibiotic residues and antibiotic resistance genes following land application of manure waste. *J Environ Qual* 38(3):1086–1108 (2009); doi:10.2134/jeq2008.0128.
- Wegener HC. Antibiotics in animal feed and their role in resistance development. *Curr Opin Microbiol* 6(5):439–445 (2003); doi:10.1016/j.mib.2003.09.009.
- Russell JB, Houlihan AJ. The ionophore resistance of ruminal bacteria and its relationship to other forms of antibiotic resistance. Paper presented at the 65th Annual Cornell Nutrition Conference for Feed Manufacturers, 21–23 October 2003, East Syracuse, NY. Available: <http://naldc.nal.usda.gov/catalog/20731> [accessed 11 March 2015].